(12) UK Patent Application (19) GB (11) 2 365 905 (13) A

(43) Date of A Publication 27.02.2002

(21) Application No 0027868.9

(22) Date of Filing 15.11.2000

(30) Priority Data
(31) 0020410 (32) 19.08.2000 (33) GB

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(51) INT CL[7]
E02B 17/02 , F03D 11/04

(52) UK CL (Edition T)
E1H HB HEA H601
F1T TDC T102 T121 T131 T149

(56) Documents Cited
GB 2327970 A GB 2186901 A
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(58) Field of Search
UK CL (Edition S) B7A AAAQ , E1H HB HCD HEA HEB, F1T TDC
INT CL[7] E02B 17/02 17/04 17/08 , F03D 11/04
Online EPODOC JAPIO WPI

(54) Abstract Title
Offshore structure with a telescopically extendable column

(57) An offshore structure comprises a watertight chamber 1 having a base 5 which rests on the seabed and a telescopically extendable shaft 3 which extends upwardly from the chamber, with a hoist 7 located at the shaft top. A wind turbine 6 may be located at the top of the shaft while a generator may be located in the base. The structure may be towed floating with the column retracted to its installation point, where the base is then ballasted to its resting position on the seabed. The column may then be extended and grouted in place, while the hoist may be used to raise the rotor hub and blades 8 to the required position at the top of the column.

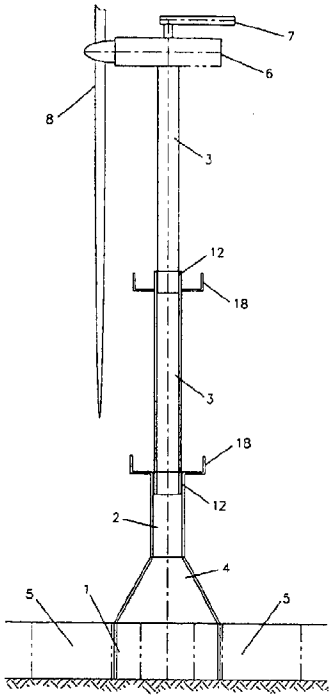

FIGURE 1

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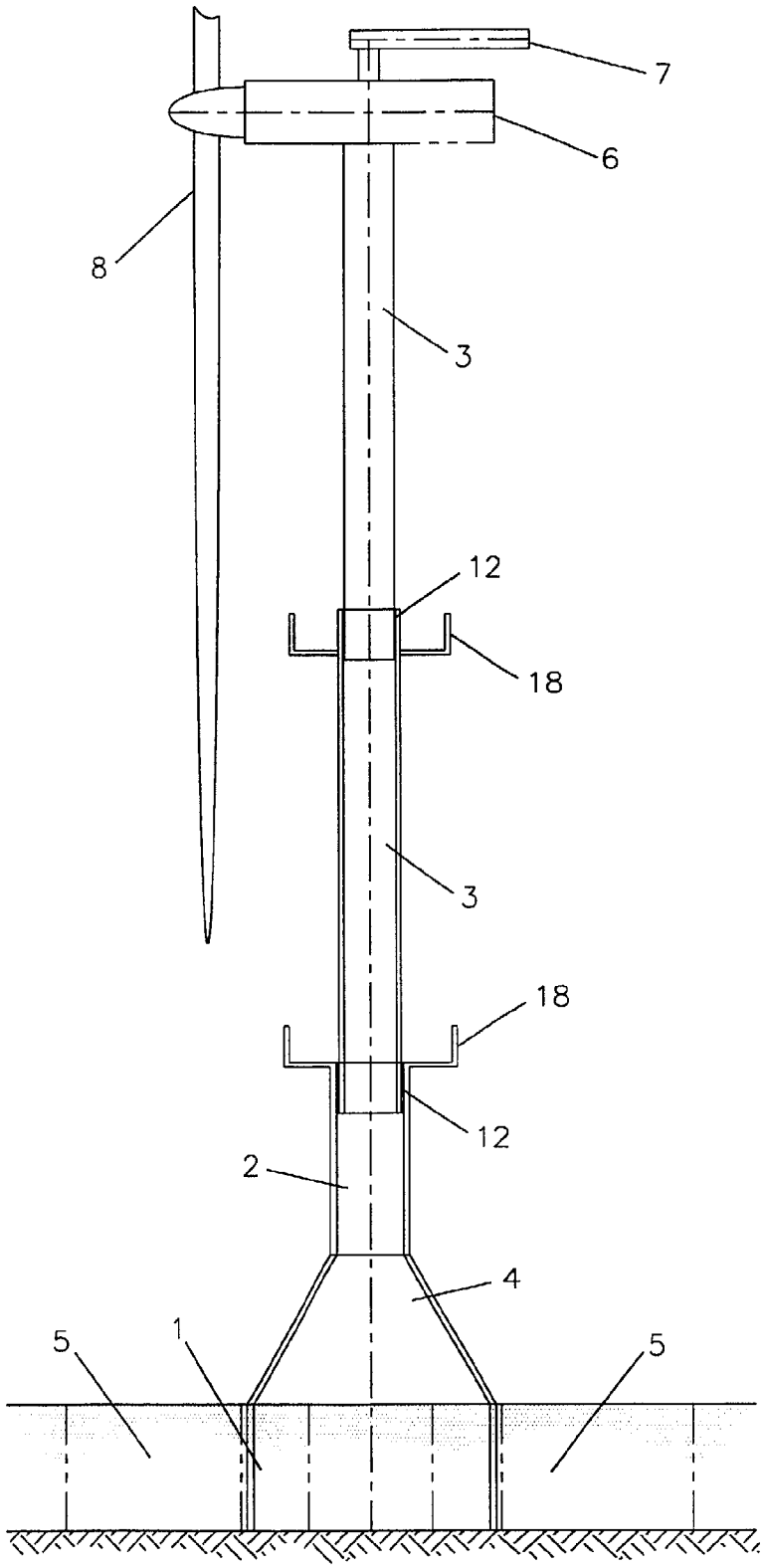

FIGURE 1

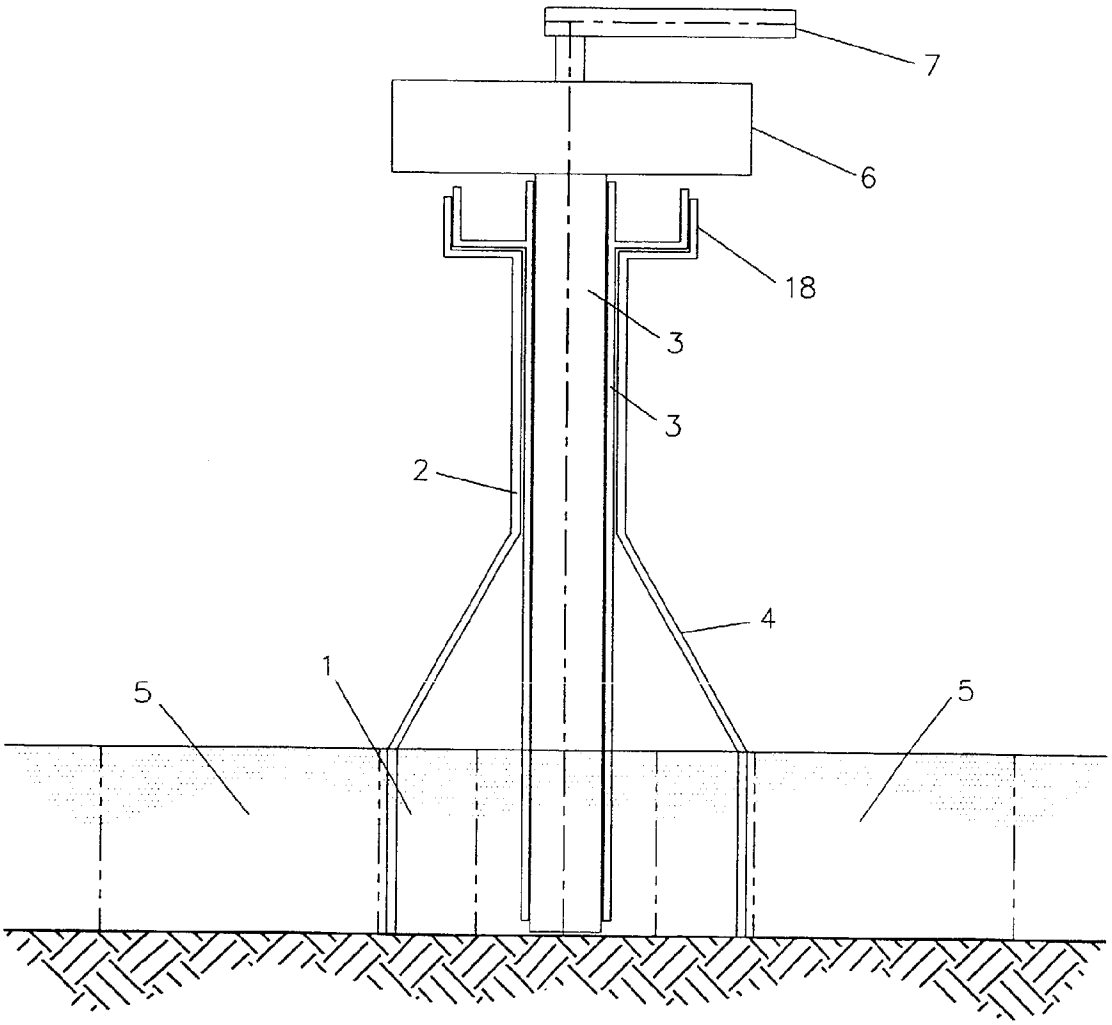

FIGURE 2

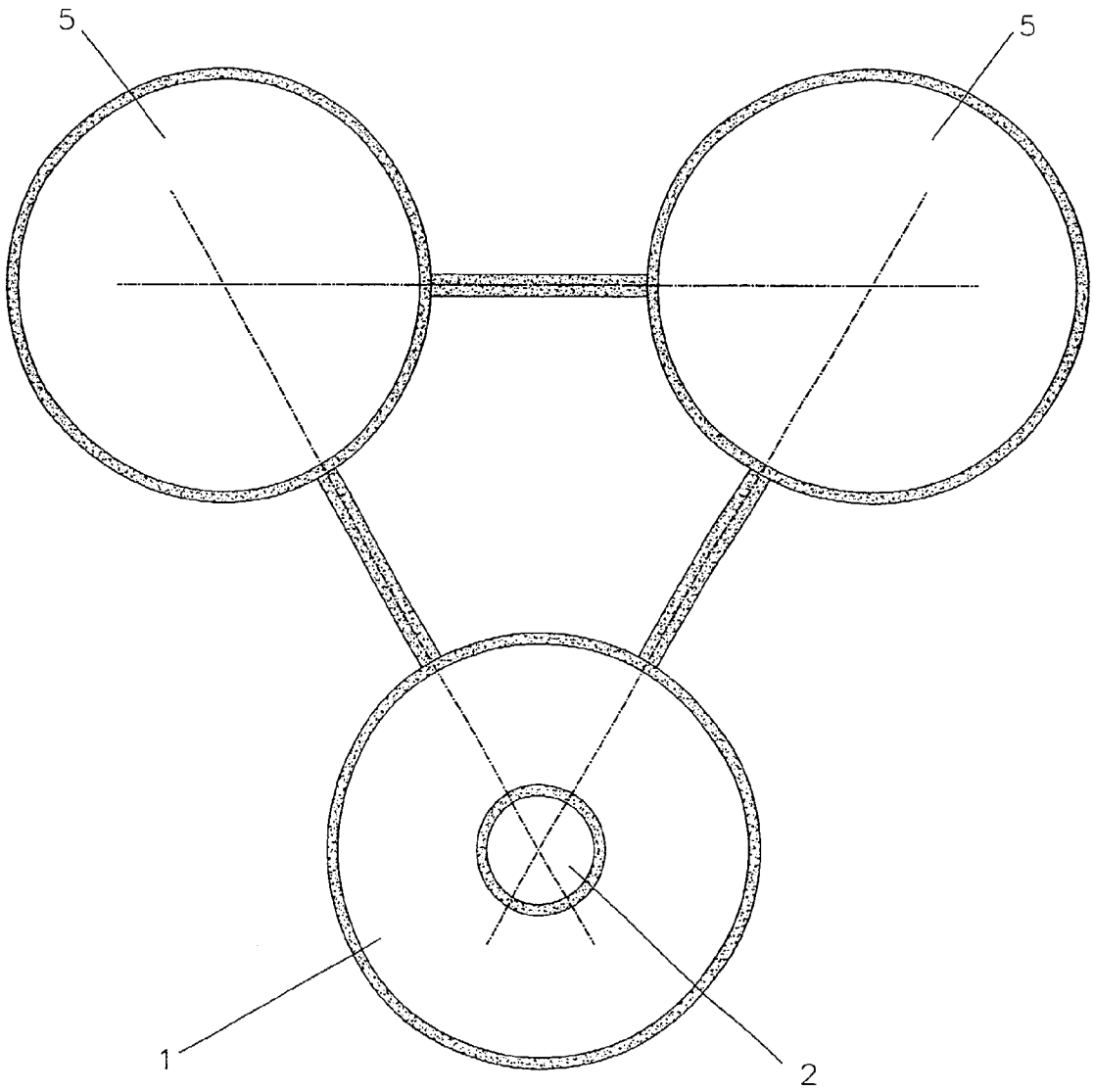

FIGURE 3

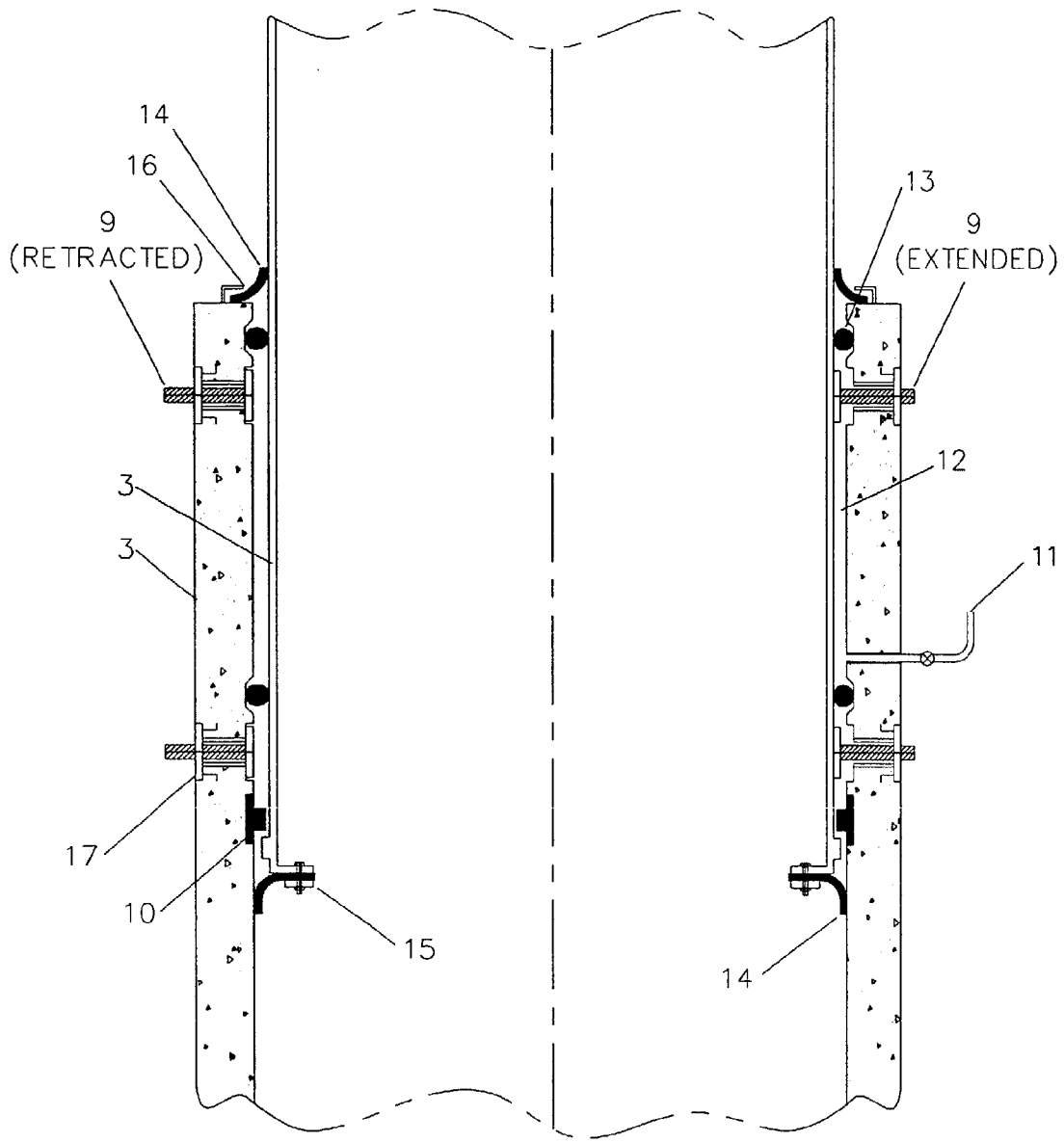

FIGURE 4

OFFSHORE WINDTOWER

This invention relates to offshore foundation structures for wind turbines.

Currently the foundation structures used for housing wind turbines offshore require that the turbine is fixed to the foundation prior to installation or that the foundation is pre-installed and the turbine fixed to it in a separate operation. A disadvantage of the first method of installation is that the turbine height above the foundation causes poor stability and an eccentric loading and instability resulting in complex and costly installation procedures. A disadvantage of the second method of installation is that the turbine has to be installed in-situ offshore requiring complex installation manoeuvres and additional floating vessels and resulting in additional costs.

We have now devised a foundation structure for offshore use with a wind turbine and installation method, which obviates the above problem.

According to the present invention there is provided a wind turbine or general equipment installation and support structure comprising a watertight chamber formed of concrete, ferrous cement, fibre-reinforced concrete or other suitable material, having a base which rests on or at the lake or seabed, and a shaft which extends upwardly from the chamber, said shaft being telescopically extendable, with a hoist located at the shaft top.

Preferably a wind turbine is located at the top of the shaft prior to installation.

However, in alternative embodiments the structure can be used to install and support other equipment for use offshore, for example telecomm's equipment or pollution detection equipment.

Preferably a plurality of chambers forms the base, allowing for modular construction.

Preferably the shaft is fully retracted during tow out, and foundation ballast and installation operations.

Preferably grout annuli are provided for locking the telescopic shaft into the fully extended position.

In one embodiment of the invention a generator is located in the base. This removes weight from the top of the structure and aids stability during tow out and installation.

During installation a rotor hub and blades are fixed to the structure subsequent to the foundation installation and to the shaft being extended.

In an alternative embodiment the rotor hub and blades are hinged to the top of the shaft at a horizontal angle enabling said hub and blades to be fitted to the structure prior to tow out and foundation installation. The hoist is then used to position the rotor hub and blades in the desired vertical position after foundation installation and shaft extension operations.

In another embodiment the blades are hinged to the rotor hub and a hydraulic jacking mechanism is provided such that the blades can be rotated into horizontal alignment. This

ensures that the blades are clear of the water surface and allows them to be fitted to the structure prior to tow out and installation. After installation and shaft extension the blades are rotated into the desired alignment by releasing the hydraulic jacks.

A specific embodiment of the invention will now be described by way of example only and with reference to the accompanying drawings in which: -

Figure 1 shows in vertical cross section the wind turbine or general equipment support structure on location with the shaft fully extended.

Figure 2 shows in vertical cross section the wind turbine or general equipment support structure on location with the shaft fully retracted.

Figure 3 shows a typical base layout in plan view.

Figure 4 shows connection details for the telescopic shaft sections.

Referring to the drawings the structure comprises a watertight chamber, 1, which is formed to include a tubular opening, 2, to allow for insertion of a telescopic shaft, 3. A cone reducer, 4, is used to lessen wind and wave loading on the Chamber, 1.

A plurality of peripheral compartments, 5, are filled with ballast during normal operation but can be fully or partly air-filled during installation, in order to provide flotation and stability. Should removal be desired the compartments, 5, can also be deballasted.

The peripheral compartments, 5, provide a sufficiently large bearing area on the seabed to ensure stability in good seabed conditions. Should other seabed conditions be encountered provision is made for other types of fixity (not shown) including pin piled, suction piled, and epoxy grout.

Figure 2 shows the structure on location after it has been ballasted to the seabed with the shaft, 3, in fully retracted position. A turbine package 6, is located at the top of the shaft, 3. The structure is set up for operation by extending the telescopic shaft, 3, to its fully extended position as shown in Figure 1. Once the shaft 3, has been locked in position a hoist, 7, located at the top of the shaft, 3, is used to lift and install the rotor hub and blades, 8. Platforms, 18, are provided for access to grout operations, for ease of maintenance, and checks.

In an alternative embodiment the rotor hub and blades, 8,are hinged (not shown) to the top of the shaft, 3, at a horizontal angle prior to installation and tow out of the foundation.

The telescopic shaft, 3, is raised using a jacking system with frame and pins (not shown) or by pressurising the chamber, 1, interior and pumping (not shown). In an alternative embodiment (not shown) the tubular opening, 2, extends to the chamber, 1, bottom so that pressure can be applied within the opening, 2, to raise the shaft, 3.

Figure 4 shows how the shaft sections, 3, are held in alignment as the shaft, 3, is raised to the extended position. This is achieved using alignment rollers, 13 (four shown) and the

alignment/ retaining plates, 9, (four shown). The alignment/retaining plates, 9, are held in place with galvanised locking rings, 17.

On reaching the desired position the telescopic shaft sections, 3, are held temporarily by screwing in the alignment/ retaining plates, 9, so that the sections, 3, can be grouted in place.

Stops, 10, ensure that the telescopic shaft, 3 is not over extended. The grout is passed through a grout fill line, 11, into a grout space, 12, and hardens to fix the shaft, 3, in position.

The grout is retained using neoprene wiper seals, 14, (four shown), secured by retaining rings, 15. A weep hole, 16, is provided at the top of the connection.

CLAIMS

1. A wind turbine or general equipment installation and support structure comprising a watertight chamber formed of concrete, ferrous cement, fibre-reinforced concrete or other suitable material, having a base which rests on or at the lake or seabed, and a shaft which extends upwardly from the chamber, said shaft being telescopically extendable, with a hoist located at the shaft top.

2. A wind turbine or general equipment installation and support structure as claimed in Claim 1 wherein a wind turbine is located at the top of the shaft.

3. A wind turbine or general equipment installation and support structure as claimed in Claim 1 or Claim 2, wherein a plurality of chambers forms the base, allowing for modular construction.

4. A wind turbine or general equipment installation and support structure as claimed in any preceding claim, wherein the shaft is fully retracted during tow out, and during foundation ballast and installation operations.

5. A wind turbine or general equipment installation and support structure as claimed in any preceding claim, wherein grout annuli are provided between shaft sections, allowing grouting for locking the telescopic shaft into the fully extended position.

6. A wind turbine or general equipment installation and support structure as claimed in any preceding claim, wherein a generator is located in the base.

7. A wind turbine or general equipment installation and support structure as claimed in any preceding claim, wherein a rotor hub and blades are fixed to the structure during installation subsequent to the foundation installation and to the shaft being extended.

8. A wind turbine or general equipment installation and support structure as claimed in any of claims 1 to 6, wherein a rotor hub and blades are hinged to the top of the shaft at a horizontal angle enabling said hub and blades to be fitted to the structure prior to tow out and foundation installation.

9. A wind turbine or general equipment installation and support structure as claimed in any of claims 1 to 6, wherein the blades are hinged to the rotor hub and a hydraulic jacking mechanism is provided such that the blades can be rotated into horizontal alignment, thereby ensuring that the blades are clear of the water surface and allowing them to be fitted to the structure prior to tow out and installation, and subsequently rotated into the desired alignment.

10. A wind turbine or general equipment installation and support structure as claimed in Claim 8 wherein a hoist is used to position the rotor hub and blades in the desired vertical position after foundation installation and shaft extension operations.

11. A wind turbine or general equipment installation and support structure as claimed in any preceding claim, wherein the peripheral compartments are filled with ballast during

normal operation, and can be fully or partly air-filled during installation, in order to provide flotation and stability.

12. A wind turbine or general equipment installation and support structure as claimed in Claim 11 wherein the peripheral compartments can be deballasted to aid removal of the structure from the seabed.

13. A wind turbine or general equipment installation and support structure as claimed in any preceding claim, wherein the structure is fixed to the seabed by use of pin piles, suction piles, epoxy grout, or other suitable fastening.

14. A wind turbine or general equipment installation and support structure as claimed in any preceding claim, wherein the telescopic shaft is raised using a jacking system with frame and pins.

15. A wind turbine or general equipment installation and support structure as claimed in any of claims 1 to 13, wherein the telescopic shaft is raised by pressurising the chamber interior and pumping, a tubular opening housing the shaft and extending to the chamber bottom so that pressure can be applied within the opening to raise the shaft.

16. A wind turbine or general equipment installation and support structure as claimed in any preceding claim, wherein the shaft sections are held in alignment as the shaft is raised to the extended position, using alignment rollers and alignment/ retaining plates, said plates being held in place with galvanised locking rings.

17. A wind turbine or general equipment installation and support structure as claimed in any preceding claim, wherein the telescopic shaft sections can be held temporarily in the raised position by screwing in the alignment/ retaining plates so that the shaft sections can be grouted in place.

18. A wind turbine or general equipment installation and support structure as claimed in any preceding claim, wherein the grout is retained using neoprene wiper seals, said seals being secured by retaining rings attached to the shaft.

19. A wind turbine or general equipment installation and support structure substantially as herein described and illustrated in the accompanying drawings.

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Application No: GB 0027868.9
Claims searched: 1 to 19

Examiner: Richard Collins
Date of search: 31 January 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): B7A AAAQ; E1H HB, HCD, HEA, HEB; F1T TDC.

Int Cl (Ed.7): E02B 17/02, 17/04, 17/08; F03D 11/04.

Other: Online EPODOC, JAPIO, WPI.

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2327970 A	(KVAERNER OIL & GAS) see figures 1 to 4.	-
A	GB 2186901 A	(BRITISH GAS) see figure 2 and related description.	-
A	GB 1334342 A	(LANGNER) see figures 1 and 3.	-
A	DE 4029932 A1	(PRETZSCH) see figures and abstract.	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.